

# Property Library for Nitrous Oxide

## LibN2O

Prof. Hans-Joachim Kretzschmar  
Dr. Sebastian Herrmann  
Dr. Matthias Kunick  
Ines Jaehne  
Tobias Goepfert

## Property Functions

Functional Dependence	Function Name	Call from Fortran Program	Property or Function	Unit of the Result
$a = f(p, t, x)$	a_ptx_N2O	A_PTX_N2O(P,T,X)	Thermal diffusivity	m <sup>2</sup> /s
$c_p = f(p, t, x)$	cp_ptx_N2O	CP_PTX_N2O(P,T,X)	Specific isobaric heat capacity	kJ/(kg K)
$c_v = f(p, t, x)$	cv_ptx_N2O	CV_PTX_N2O(P,T,X)	Specific isochoric heat capacity	kJ/(kg K)
$\eta = f(p, t, x)$	eta_ptx_N2O	ETA_PTX_N2O(P,T,X)	Dynamic viscosity	Pa . s
$h = f(p, t, x)$	h_ptx_N2O	H_PTX_N2O(P,T,X)	Specific enthalpy	kJ/kg
$\kappa = f(p, t, x)$	ka_ptx_N2O	KA_PTX_N2O(P,T,X)	Isentropic exponent	-
$\lambda = f(p, t, x)$	lam_ptx_N2O	LAM_PTX_N2O(P,T,X)	Thermal conductivity	W/(m . K)
$\nu = f(p, t, x)$	ny_ptx_N2O	NY_PTX_N2O(P,T,X)	Kinematic viscosity	m <sup>2</sup> /s
$Pr = f(p, t, x)$	pr_ptx_N2O	PR_PTX_N2O(P,T,X)	<i>Prandtl</i> -number	-
$p_s = f(t)$	ps_t_N2O	PS_T_N2O(T)	Vapor pressure from temperature	bar
$\rho = f(p, t, x)$	rho_ptx_N2O	RHO_PTX_N2O(P,T,X)	Density	kg/m <sup>3</sup>
$s = f(p, t, x)$	s_ptx_N2O	S_PTX_N2O(P,T,X)	Specific entropy	kJ/(kg K)
$\sigma = f(t)$	sigma_t_N2O	SIGMA_T_N2O(T)	Surface tension from temperature	N/m
$t = f(p, h)$	t_ph_N2O	T_PH_N2O(P,H)	Backward function: Temperature from pressure and enthalpy	°C
$t = f(p, s)$	t_ps_N2O	T_PS_N2O(P,S)	Backward function: Temperature from pressure and entropy	°C
$t_s = f(p)$	ts_p_N2O	TS_P_N2O(P)	Saturation temperature from pressure	°C
$u = f(p, t, x)$	u_ptx_N2O	U_PTX_N2O(P,T,X)	Specific internal energy	kJ/kg
$v = f(p, t, x)$	v_ptx_N2O	V_PTX_N2O(P,T,X)	Specific volume	m <sup>3</sup> /kg
$w = f(p, t, x)$	w_ptx_N2O	W_PTX_N2O(P,T,X)	Isentropic speed of sound	m/s
$x = f(p, h)$	x_ph_N2O	X_PH_N2O(P,H)	Backward function: Vapor fraction from pressure and enthalpy	kg/kg
$x = f(p, s)$	x_ps_N2O	X_PS_N2O(P,S)	Backward function: Vapor fraction from pressure and entropy	kg/kg

**Units:**  $t$  in °C  
 $p$  in bar  
 $x$  in (kg saturated steam)/(kg wet steam)

### Range of validity

Temperature range: from - 90.82 °C to 251.85 °C  
Pressure range: from 0.8784 bar to 500 bar

### Reference state

$h = 0$  kJ/kg and  $s = 0$  kJ/(kg K) at  $p = 1,01325$  bar on the saturated liquid line ( $x = 0$ )

### Details on the vapor fraction $x$

The wet steam region is calculated automatically by the subprograms. For this purpose the following fixed details on the vapor fraction  $x$  are to be considered:

#### Single-phase region

If the state point to be calculated is located in the single-phase region (liquid or superheated steam)  $x = -1$  must be entered as a pro-forma value.

#### Wet-steam region

If the state point to be calculated is located in the wet steam region, a value for  $x$  between 0 and 1 ( $x = 0$  for saturated liquid,  $x = 1$  for saturated steam) must be entered. In this case, the backward functions result in the appropriate value between 0 and 1 for  $x$ . When calculating wet steam either the given value for  $t$  and  $p = -1000$  or the given value for  $p$  and  $t = -1000$  and in both cases the value for  $x$  between 0 and 1 must be entered.

If  $p$  and  $t$  and  $x$  are entered as given values, the program considers  $p$  and  $t$  to be appropriate to represent the vapor pressure curve. If this is not the case the calculation for the property of the chosen function results in  $-1$ .

Wet steam region: Temperature ranges from  $t_{\min} = - 90.82$  °C to  $t_c = 36.37$  °C  
Pressure ranges from  $p_{\min} = 0.8784$  bar to  $p_c = 72.447$  bar

### Note:

*If the input values are located outside the range of validity, the calculated function will always result in  $-1000$ . Please find more exact details on every function and its corresponding range of validity in the enclosed program documentation in Chapter 3.*